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Designing Flood Early Warning System Using Internet of Things

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Abstract. Internet of things technology has grown rapidly in recent years. Internet of things can be used for environmental monitoring to make an early warning system for disaster. This technology is much needed to warn people about flood that usually happen in Jakarta. In this prototype water level sensor are used to measure whether the water level has reached a dangerous state and flow rate sensor is used to measure flow rate. In this paper the number of notification sent and the time it needed since water level has reached a dangerous state until a notification alert is received is measure to see if the notification can be receive before flood happens. The result shows that most of the notification received before flood happens. The states of the sensor and internet speed affect the process to send the notification.

INTRODUCTION

The rapid development of technology nowadays has caused the technology to be integrated in many aspect of human's life. One of the rapidly developing technologies is internet of things. Internet of things can be described as a technology that connect physical things with computing capabilities across a wide range of services and technologies [1].

Internet of things can be used to monitor the environment such as water level, flow rate, rainfall and many other things. Because of this, there are many early warning systems for disaster is integrated with internet of things.

Early warning system for disaster especially flood is needed in Jakarta. From 2011 to 2016, 1210 flood occurred in Indonesia and 48 of them occurred in Jakarta [2]. Because of this, the demand of technology to alert citizen is high and it has to be fast, accurate, and dependable.

From this problem, the writer proposed a method to give alert notification about alert status via e-mail or SMS. The writer creates a prototype of flood early warning system with 2 sensor, the first one is to measure the water level and the second one is to measure the flow rate.

FLOOD EARLY WARNING SYSTEM

Flood early warning system is a device that will measure the water level which will enable to know the amount of water in a river, it will also know if the water have reached the condition where it's necessary to alert people about the water that has potential to overflow and cause floods [3]. In flood early warning system, cloud computing acts as a receiver of data from the sensor, as a computer to analyze, interpret, and providing user with easy to understand web based visualization of the data [4]. In this paper to create the prototype, the writer used 2 sensors, which is a

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water level sensor and flow rate sensor, a LinkIt One PCB board, and ubidots as a server to collect data, analyze, and sending alert.

Water Level Sensor

Water level sensor is used for water detection, which can be used in sensing the rainfall, liquid leakage, or in this paper it's used to detect water level.

TABLE 1. Water level sensor specification

Specification	Minimum	Maximum
Sensor Type	Analog	
Operating Voltage	3V	5V
Working Current	1mA	20mA
Dimensions	65mm x 20 mm x 8mm	
Detection Area	40 mm x 16 mm	

The specifications listed on table 1 above is the specification of water level sensor used in this paper are listed on table below and taken from www.fecegypt.com. The detection area of this sensor is 40 mm x 16 mm. This sensor works by having a series of exposed traces connected to ground and when water made contact with the exposed traces the sensor will detect it and send the data to PCB as a number. The number depends on how big is the surface that made contact with water [5]. It can't detect anything that haven't made contact with the sensor.

Flow Rate Sensor

Flow rate sensor is used to detect the size of the flow of water.

TABLE 2. Flow rate sensor specification

Specification	Minimum	Maximum
Sensor Type	Digital	
Operating Voltage	3V	18V
Working Current	1mA	15mA
Water Pressure	-	1.75MPa
Flow Rate	1 L	30 L

The specifications listed on table 2 above is the specification of flow rate sensor used in this paper are listed on table below and taken from www.microelectronics.com. The flow rate that can be detected with this sensor is between 1 litre to 30 litres and this sensor works by having the water flows through rotor components, magnetic rotor rotating, and speed along with the flow of a linear change then hall element output corresponding pulse signal feedback to the controller [6].

LinkIt One

According to wiki.seeed.cc [7] LinkIt One is a PCB board made by collaboration of Seeed Studio and MediaTek to made a prototype of devices embedded with internet of things.

TABLE 3. LinkIt One PCB Board specification

Specification	Value
Dimensions	3.3 x 2.1 inches
RAM	4 MB
Digital Output	3.3v
Analog Input	5v
DC Current per I/O pin	1mA

The specifications of LinkIt One PCB board are listed on table below and taken from official LinkIt One website. This PCB will be used as main processor of the prototype created in this experiment.

Ubidots

According to www.ubidots.com [8] Ubidots is an engineering services firm, specializing in hardware and software development for internet of things projects. In ubidots, the data from sensor will be analyzed and presented as a line diagram. Ubidots also provide the feature to send SMS and e-mail.

METHODOLOGY

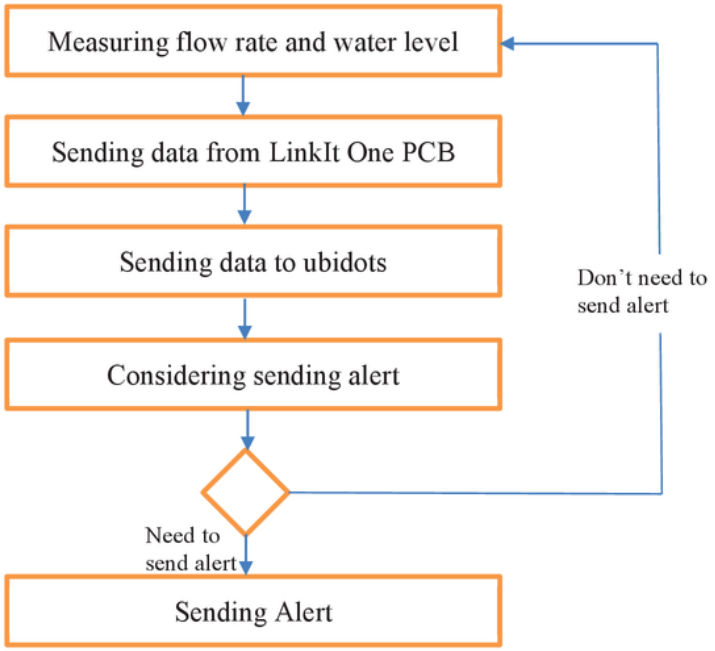

CHART 1. Methodology used in this experiment

Using the technology listed on the previous parts, a method can be devised. There are 5 steps for the method
Step 1: Measuring flow rate and water level

Flow rate will be measured every second with flow rate sensor to get an actual data.

Step 2: Sending data from LinkIt One PCB

After sensor receive the data. The data will be sent to LinkIt One PCB to be processed.

Step 3: Sending data to ubidots

The data processed by LinkIt One will be received by ubidots. After ubidots received the data, a list will be made in ubidots sorted by the time of the data received and a graph is made based on the data.

Step 4: Considering sending alert

At this step ubidots will identify the data and compare it with a predetermined threshold. If the data exceed the predetermined threshold, alert will be sent.

Step 5: Sending Alert

If the data exceed the predetermined threshold alert will be sent via ubidots to e-mail and phone number listed in ubidots. If not the step will repeat the first step.

Data Resources

In this paper the authors conduct an experiment using flood early warning system prototype made by the author. The data obtained from the prototype are flow rate and data from water level sensor. The experiments have 3 sessions and every session indicate different condition. The conditions indicate by this experiment is:

1. When the flow rate every minute is below the limit of the container.
2. When the flow rate every minute equals the limit of the container.
3. When the flow rate every minute is more than the limit of the container.

The container used in this experiment has height and diameter respectively 24 cm and 22 cm and has a tube shape which means limit of the container in this experiment is 9.118 litres while the water level sensor is placed at respectively 5 cm, 10 cm, 15 cm, and 20 cm from the bottom of the container. The position of the water level sensor is based on Seal (2012) works [9].This indicate the *Alert* level in Indonesia which is *Alert 1, Alert 2, Alert 3,* and *Alert 4*.

EVALUATION

To evaluate the result, the author use the Accuracy formula [10] listed below:

$$Accuracy = \frac{b}{a} * 100\%$$

The function of this formula is to prove whether the prototype can work properly by calculating the

- b is number of alert received
- a is amount of alert that should be sent

For example if the prototype supposed to receive 10 alert but only 7 alert sent therefore the calculation will be

$$Accuracy = \frac{7}{10} * 100\%$$

That means the accuracy is 70%.

RESULT

In this experiment the container used has a 22 cm diameter, 24 cm height, and 9.118 litres volume. The result of the experiment can be seen below.

TABLE 4. flow rate 1 litre – 7 litre

No.	Flow rate average (Litre /minute)	Water level sensor height (centimeter)	Alert status (sent or not sent)	Time needed to received alert notification	Status *Alert*	Time needed to fill container
1	±1 L/min	5 cm	-	-	*Alert* IV	540 sec
2	±2 L/min	5 cm	-	-	*Alert* IV	270 sec
3	±3L/min	5 cm	-	-	*Alert* IV	180 sec
4	±4 L/min	5 cm	-	-	*Alert* IV	135 sec
5	±5 L/min	5 cm	-	-	*Alert* IV	108 sec
6	6.812 L/min	5 cm	✓	15 sec	*Alert* IV	90 sec
	6.737 L/min	10 cm	-	-	*Alert* III	
7	7.477 L/min	5 cm	✓	17 sec	*Alert* IV	78 sec
	7.241 L/min	10 cm	✓	30 sec	*Alert* III	
	7.886 L/min	15 cm	-	-	*Alert* II	
✓: Alert sent						

From the table above, can be seen that the prototype get the correct result of 3 times out of all 3 experiments. The flow rate average of 1 to 5 litres and the second 6 litres experiment and the third 7 litres experiment stop midway because there's no way the water to reach the height required since the water flow out before it can fill the container.

In the second experiment the author get result listed in the table below:

TABLE 5. flow rate 8 litre – 9 litre

No.	Flow rate average (Litre /minute)	Water level sensor height (centimeter)	Alert status (sent or not sent)	Time needed to received alert notification	Status *Alert*	Time needed to fill container
1	8.683 L/min	5 cm	✓	14 sec	*Alert* IV	68 sec
	8.132 L/min	10 cm	✓	28 sec	*Alert* III	
	8.498 L/min	15 cm	✓	40 sec	*Alert* II	
	8.812 L/min	20 cm	✓	52 sec	*Alert* I	
2	9.315 L/min	5 cm	✓	12 sec	*Alert* IV	60 sec
	9.791 L/min	10 cm	✓	22 sec	*Alert* III	
	9.872 L/min	15 cm	✓	35 sec	*Alert* II	
	9.805 L/min	20 cm	✓	45 sec	*Alert* I	
✓: Alert sent						

Based on table 5 above can be seen that in all experiments alert notification was sent correctly and can be seen that everytime the notification sent, the time needed always under the time needed to fill the container.

The result of the third experiment can be seen below:

TABLE 6 .flow rate more than 9 litre

No.	Flow rate average (Litre /minute)	Water level sensor height (centimeter)	Alert status (sent or not sent)	Time needed to received alert notification	Status *Alert*	Time needed to fill container
1	10.524L/min	5 cm	✓	11 sec	*Alert* IV	54 sec
	10.174L/min	10 cm	✓	20 sec	*Alert* III	
	10.846L/min	15 cm	✓	32 sec	*Alert* II	
	10.538L/min	20 cm	✓	45 sec	*Alert* I	
2	15.542L/min	5 cm	✓	7 sec	*Alert* IV	37 sec
	15.204L/min	10 cm	✓	14 sec	*Alert* III	
	15.696L/min	15 cm	-	-	*Alert* II	
	15.173L/min	20 cm	✓	30sec	*Alert* I	
3	20.498L/min	5 cm	✓	5 sec	*Alert* IV	27 sec
	20.662L/min	10 cm	✓	11 sec	*Alert* III	
	20.319L/min	15 cm	✓	17 sec	*Alert* II	
	20.121L/min	20 cm	✓	22 sec	*Alert* I	
✓: Alert sent						

From the table above can be seen that in every experiment except the third 15 litres the notification was sent and receive before it reached the time needed to fill the container. On the third 15 litres notification was not sent, this probably happens because of the internet connection was down at the time the experiment is done.

After all the experiment is done the accuracy is calculated with the formula discussed in the previous chapter, this prototype have 95.6% accuracy.

RESULT

Based on the result of experiments done, the flood early warning system work properly this can be seen by the accuracy achieved.

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